PTO 07-6137

CC=JP DATE=19990112 KIND=A
PN=11005413

PNEUMATIC RADIAL TIRE
[Kuuki Iri Rajiaru Taiya]

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UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. August 2007

Translated by: FLS, Inc.

PUBLICATION COUNTRY	(19):	JP
DOCUMENT NUMBER	(11):	11-5413
DOCUMENT KIND	(12):	A
PUBLICATION DATE	(43):	19990112
APPLICATION NUMBER	(21):	09-161271
DATE OF FILING	(22):	19970618
ADDITION TO	(61):	
INTERNATIONAL CLASSIFICATION	(51):	B 60 C 11/11, 11/04, 11/12
PRIORITY	(30):	
INVENTORS	(72):	HIMURO, YASUO
APPLICANT	(71):	BRIDGESTONE INC.
DESIGNATED CONTRACTING STATES	(81):	
TITLE	(54):	PNEUMATIC RADIAL TIRE
FOREIGN TITLE	[54A]:	KUUKI IRI RAJIARU TAIYA

[Claims]

[Claim 1] A pneumatic radial tire, characterized as a pneumatic radial tire having

a tread road surface portion that in addition to being divided into two side areas and

a center area by a pair of circumferential main grooves that extend in a straight line in a circumferential tread,

in a center area, steeply slanted grooves open in both circumferential main grooves, and

in both side areas, multiple block lines are formed having gently slanted grooves opening on the circumferential main grooves and tread adjacent area edges, and in each block, multiple rows of sipes extend slanted in a lateral tread direction, and

together with each block of a center area formed almost as a parallelogram,

circumferential tread length of that block is in a range of twice to five times the length of an adjacent block of a side area, and

blocks in a center area have multiple groups of sipes where one group is comprised of multiple rows of sipes.

[Claim 2] A pneumatic radial tire as in Claim 1, characterized by the number of sipe rows of a construction of a group of sipes on a side area being about the same as the number of sipe rows formed on an adjacent single block.

[Claim 3] A pneumatic radial tire as in either Claim 1 or Claim 2, characterized by steeply slanted grooves, where the range of an angle on the acute angle side vis-à-vis a circumferential tread is 10 - 45 degrees, and the range for a similar angle on a gently slanted groove is 60 - 90 degrees.

[Claim 4] A pneumatic radial tire as in any of Claims 1 - 3, characterized by providing a straight circumferential secondary groove between a pair of circumferential main grooves that is narrower in width than those main grooves.

[Claim 5] A pneumatic radial tire as in any of Claims 1 - 4, characterized by 2 - 6 individual sipe groups of a center section block.

[Claim 6] A pneumatic radial tire as in any of Claims 1, 3 - 5, characterized by a construction of one group of sipes having a range of 4 - 8 rows of sipes.

[Claim 7] A pneumatic radial tire as in any of Claims 1 - 6 with a sipe group constructed where a space between circumferential treads of a sipe group is almost twice the same space between sipes.

[Detailed explanation of invention]

[0001] [Technical field of invention]

This invention of a pneumatic radial tire, being among those all weather tires that consider winter performance, pertains to a tread pattern that increases wet performance and ice performance without sacrificing snow performance and other performance.

[0002] [Previous technology]

For tread patterns of all weather type tires, a block pattern that combines lateral grooves and circumferential main grooves extending in a straight line or zigzag condition is common, and in this tread pattern, an increase in hydroplaning resistance performance by means of widening a groove to increase a negative ratio, and an increase in water displacement capability with a small angle slant of lateral grooves vis-à-vis a circumferential tread direction, in other words with a steeply slanting a groove it is possible to achieve various effects, in this case, slanting grooves and such mainly in a lateral tread, then, circumferential grooves in a tread circumference direction function in order to displace water.

[0003] Also, for performance of a tire on snow, although assurance of snow shearing force is realized through a block pattern, then ice capability is assured by block circumferential rigidity, it is common to realize cutting through water by having multiple rows of sipes constituting the lateral tread edges.

[0004] [Issues the invention proposes to solve]

However, in a block pattern tire that is ideal for realizing snow performance, in a case of arranging multiple rows of sipes in a block planning for assurance of ice performance, circumferential rigidity of blocks becomes too low, so there are times when improvement of snow performance and wet braking efficiency and such are not sufficient, and on the other hand, in a case of assuring an

increase in ice performance by forming multiple rows of sipes in ribs of a rib pattern tire, the ribs do not generate snow shearing force, resulting in an inevitable disadvantage of a decrease in snow performance.

[0005] This invention, as a result of analyzing the issues in solving the kind of problem points inherent in prior technology, making it an objective, provides assurance of superior snow performance by means of a block pattern, especially, by providing a pneumatic radial tire with a block formation and dimensions, and by applying a contrivance of a sipe formation feature, that collectively makes possible favorably improved braking efficiency even in ice performance and wet performance and reduces the effects of pattern noise.

[0006] [Methods to solve the issues]

A pneumatic radial tire of this invention, is characterized by having a tread road surface portion that in addition to being divided into two side areas and a center area by a pair of circumferential main grooves that extend in a straight line in a circumferential tread, in a center area, steeply slanted grooves open in both circumferential main grooves, and in both side areas, multiple block lines are formed having gently slanted grooves opening on the circumferential main grooves and tread adjacent area edges, and in each block, multiple rows of sipes extend slanted in a lateral tread direction, and together with each block of a center area formed

almost as a parallelogram, circumferential tread length of that block is in a range of twice to five times the length of an adjacent block of a side area, and blocks in a center area have multiple groups of sipes where one group is comprised of multiple rows of sipes.

[0007] In a center tread area of a pneumatic radial tire, a high rib form section with circumferential rigidity is provided, and even though arranging multiple rows of sipes is effective to assure superior ice performance, especially among them braking efficiency, /3
in order to assure snow shearing force and wet water dispersion capability in snow, as in this invention, providing long blocks with high rigidity in a circumferential direction by separating with steeply slanted grooves is effective.

[0008] Also, in this pneumatic radial tire, by making the length of circumferential tread of center area blocks in a range of 2 - 5 times that of adjacent side area blocks, circumferential rigidity of blocks is high enough, but on the other hand, by providing more than two sipe groups with multiple rows of sipes in that block, it is possible to favorably increase braking efficiency on icy and wet roads without lowering block rigidity.

[0009] At this point, in a case of circumferential length of center area blocks being less than double, it is difficult to assure sufficient block rigidity corresponding to the formation of multiple sipe groups, while on the other hand, when exceeding 5 times the length, circumferential block rigidity becomes too high, sufficient

road hugging is not obtained due to short grounding length, and it cannot obtain snow traction.

[0010] As in the above pneumatic radial tire, it is desirable that the number of sipe rows formed in one group is the same as one block in an adjacent side area. By doing this, it is possible to fix all tread areas with a setting of sipe rows appropriate to correspond to the hardness and rigidity ratio inherent to a tread compound.

[0011] It is also desirable to make an acute angle side angle of a steeply slanted groove in a range of 10 - 45 degrees vis-à-vis a circumferential tread, and the same angle on a gently slanted groove in a range of 60 -90 degrees. In other words, in a case where an incline angle of a steeply slanted groove is 45 degrees or less, it makes it possible to collectively, together with raising circumferential rigidity of a block, realize smooth wet water displacement efficiency, and limit pattern noise generated by harsh contact to a road surface by the groove edge of a steeply slanted groove. However, if that is less than 10 degrees, effective snow shearing force for snow traction becomes too small. Also, in a gently slanted groove, by making a slant angle range 60 - 90 degrees, it is possible to increase operational stability with smooth and quick water displacement to a grounding edge from a circumferential main groove, and also increase side rigidity of blocks.

[0012] It is also desirable, between a pair of circumferential main grooves, for example, in a center area of both circumferential

grooves, at a narrower width than those circumferential main grooves, to provide a straight circumferential auxiliary groove extending to intersect steeply slanted grooves. This straight circumferential auxiliary groove, besides improving water displacement of circumferential tread in a center area, increases road hugging capability. On top of that, this straight circumferential auxiliary groove, by the fact that the groove width is narrow compared to a circumferential main groove, it is possible to favorably increase rigidity of center treads and ease of operation.

[0013] So, in this pneumatic radial tire, in a case of 2 - 6 sipe groups of center area blocks, while obtaining an edge effect for adequate water dispersion on ice, it is possible to preserve front to back block rigidity and preserve wet braking ability.

[0014] It is also desirable to have one sipe group constructed of 4 - 8 rows of sipes. In other words, when sipe rows are less than 4 rows, the effect of cutting through water, water dispersion and such due to a sipe group is small, and exceeding 8 rows, a block loses its rigidity maintenance capability due to the space portion deliberately left between sipe groups.

[0015] It is also desirable for circumferential tread sipe group space to be about double the same sipe space formed by a sipe group. Here, in order to generate a sufficiently effective edge effect for braking and traction, sipes tend to extend in a tread lateral direction, in this case, together with making a long sipe edge, in

order to prevent effectively reducing rigidity of the land portion narrowed by sipes, it is desirable to extend sipes in a zigzag fashion.

[0016] Also, in this case, in order to further prevent reduction of rigidity of a sipe space land portion, it is desirable to alternately open in mutually different grooves provided in block separations so only one sipe edge each mutually adjoins in a group. However, in a case of a sipe space being about double the space of a sipe group, it is possible to sufficiently preserve rigidity of the space of a sipe group. Moreover, it is possible to efficiently preserve rigidity of a sipe space portion inside a group by making sipe space greater than 4 mm.

[0017] [Implementation form of invention]

Below, a form of implementation of this invention is explained based on points shown in the figures. Figure 1 is a tread pattern spread figure showing one implementation form of this invention. Also, additional internal strengthening of a tire is the same as common radial tires and is omitted from the figure.

[0018] Here, a tread road surface portion is provided with a pair of circumferential main grooves 1 extending continuously in a straight line through circumferential tread, and those circumferential main grooves 1 have a center area 2 of tread road surface portion, and together with each dividing both side areas 3 positioned on each side portion, the center part of center area 2 is

a narrower width than circumferential main grooves 1, providing circumferential auxiliary grooves 4 extending continuously in a straight line through circumferential tread, also, in the center portion of each side area 3, a circumferential narrow groove 5 is provided extending continuously in a straight line through circumferential tread.

[0019] Also, in center area 2, steeply slanted grooves 6 are opened in both circumferential main grooves 1, extending to intersect with circumferential auxiliary grooves 4, these steeply slanted grooves 6 on an acute angle side have an angle value θ_1 whose value is in a range of 10 - 45 degrees vis-à-vis circumferential tread. Steeply slanted grooves 6 that are illustrated, however, have an almost lightning shaped bent portion in circumferential auxiliary groove 4 position, the front to back of the bent portions extending mutually parallel.

[0020] Then, in each side area 3, gently slanting grooves 7 are formed opening to both circumferential main grooves 1 and grounding edge TE, these gently slanting grooves 7 on an acute angle side have an angle value θ_2 whose value is in a range of 60 - 90 degrees vis-à-vis circumferential tread. Gently slanted grooves 7 that are /4
illustrated, moreover, because they are somewhat curved in the space between grounding edge TE and circumferential main grooves 1, in this case of above angle θ_2, it means the angle in each of a divided area facing circumferential main grooves 1 and in a grounding edge area,

and this is similar to a case of the bending and such of steeply slanted grooves 6.

[0021] By these things, at this point, a total of six block lines are formed in the space between tread grounding edge TE and circumferential narrow groove 5, and the spaces between each circumferential main groove 1, and circumferential auxiliary grooves 4 and circumferential narrow grooves 5, and together with almost forming a parallelogram of center blocks 8 of each block line of center area 2, circumferential tread length of those blocks 8 are in a range of 2 - 5 times the same length as adjacent blocks 9 of side areas 3.

[0022] Moreover, in the blocks of each block line, multiple rows of zigzag shaped sipes are formed leaning in a lateral tread direction. In center blocks 8 of center area 2, in the center area of that circumferential tread, together with having center sipes 10 opened mutually against each steeply slanted groove 6, on each side of circumferential tread of those center sipes 10, it is desirable to position circumferential space t more than 4 mm, and two rows each of sipes 11 are provided mutually opening on only one end in each of the mutually opposing steeply slanted grooves 6, making five rows of sipes 10, 11 into one group substantially parallel to a center line, also, on both individual portions of circumferential tread of center blocks 8, in an area where block width gradually narrows, in each of the mutually opposing steeply slanted grooves 6 and circumferential

main grooves 1 and circumferential auxiliary grooves 4, only one end is mutually opened, and seven rows of sipes 12 substantially parallel to a center line are provided at a desirable circumferential distance t greater than 4 mm, each seven rows of sipes 12 making one sipe group. Because of this it means one center block 8 is formed from three groups of sipes. However, it is desirable that circumferential space 1 of mutual sipe groups is about double sipe circumferential space t.

[0023] Also, at this point, in each block 9 adjacent to circumferential main groove 1, four rows of sipes 13 are formed with almost equal spacing vis-à-vis the circumferential tread having the same leaning as that block 9, and in shoulder block 14 in the space between tread edge TE and circumferential narrow grooves 5, three rows of sipes 15 are formed with almost equal spacing vis-à-vis the circumferential tread having the same leaning as shoulder block 14.

[0024] In the kind of center block 8 shown, however, a sharp tapering portion 16 is created on each edge portion of circumferential tread, and because rigidity of this tapering portion is low it becomes the cause of unusual wear, impact noise and such, in this case, it is desirable to provide tapering portion 16 with the necessary rigidity by gradually decreasing a surface level of a block towards the peak side in tapering portion 16 executing the kind of molding shown by oblique lines in the figure.

[0025] For a tread pattern with this kind of construction, especially with the form and dimensions of center block 8 and based on the formation features of sipes around there, as was explained before, it is of course collectively possible to have superior snow performance and high ice performance and wet performance, and also realize reduction of pattern noise.

[0026] [Implementation example]

Below, an implementation example pertaining to snow and ice performance and wet performance and such of a pneumatic radial tire of this invention is explained.

[0027] Various tests were done with pneumatic radial tires like the implementation example of this invention for use in a passenger automobile with size 195/65R15, tread width 146 mm, and a tread pattern as shown in figure 1 mounted on a standard rim, with air pressure of 2.2 kgf/cm^2, and a load equivalent to two passengers in the car, achieving the results shown in table 1. For the values in the table, moreover, using as a control an index number of previous tires identical to the implementation example but having the tread pattern shown in Figure 2, the large index values show the superior results.

[0028] [Table 1]

	Prior Tires	Implementation Example Tires
Feeling efficiency on snow	100	105
Braking efficiency on ice	100	120
Wet braking efficiency	100	110
Hydroplaning resistance (straight line)	100	110
Dry operation stability	100	105
Pattern noise	100	110

[0029] At this point moreover, table 2 and table 3 show statistical dimensions of previous tires and implementation example tires.

[Table 2]

/5

Item	Width (mm)	Angle (°)	
Circumferential main grooves (1)	7	0	
Steeply slanted grooves (6)	6	20	
Gently slanted grooves (7)	6 - 7	60 - 80	
Circumferential auxiliary groove (4)	4	0	
Circumferential narrow groove (5)	2	0	
Zigzag sipe (11)	0.5	90 (center)	Sipe space t = 4 mm
Zigzag sipe (13)	0.5	70	Sipe space t = 4.5 mm
Zigzag sipe (15)	0.5	80	Sipe space t = 6 mm
Under tread area portion		Narrow angle 20	Area length = 25 mm
Sipe group space ℓ			ℓ = 8 mm

[0030] * * [Table 3]

Item	Width (mm)	Angle (°)	
Circumferential main grooves (21)	6 - 8	0	
Zigzag main grooves (22)	6 - 7	0	
Gently slanted grooves (23)	6	80	
Gently slanted grooves (24)	9	85	
Gently slanted grooves (25)	10	90	
Circumferential narrow grooves (26)	4	0	
Zigzag sipe (27)	0.5	80	Sipe space 5 mm
Zigzag sipe (28)	0.5	80	Sipe space 5 mm
Zigzag sipe (29)	0.5	80	Sipe space 5 mm

[0031] Also at this point, for feeling efficiency on snow, overall feeling appraisals of braking characteristics, acceleration characteristics, straight advancing characteristics and cornering efficiency on a packed snow road surface test course were appraised, and for braking efficiency on ice, the stopping distance after fully applying brakes while traveling at a speed of 20 km/hr on ice was appraised, and for wet braking efficiency, the stopping distance after fully applying brakes while traveling at a speed of 80 km/hr in 2 mm of water on a straight road surface was appraised, and for hydroplaning resistance, a feeling appraisal of the critical speed at which the hydroplaning effect was first felt over a wet straight line road surface in 5 mm of water was appraised, and for dry operation stability, a feeling appraisal of a test driver in various modes of sport traveling over a dry circuit course was appraised, and then for pattern noise, a feeling appraisal of the interior sound level of a car traveling over a straight smooth course at 100 km/hr was appraised.

[0032] According to Table 1, in the implementation example tire, in addition to preserving superior snow feeling efficiency and dry operation stability, it is possible to greatly increase both ice and wet braking efficiency as well as hydroplaning resistance, but also, it effectively solves having a decrease in pattern noise.

[0033] [Invention effects]

Thus, with this invention, without sacrificing snow and other efficiency, it is possible to collectively largely increase ice efficiency and wet efficiency together with effectively decreasing pattern noise.

[Simple Explanation of the Figures]

[Figure 1] A tread pattern spread figure showing one implementation example of this invention.

[Figure 2] A tread pattern spread figure showing a prior example.

[Explanation of markings]

1 - Circumferential main groove

2 - Center area

3 - Side area

4 - Circumferential auxiliary groove

5 - Circumferential narrow groove

6 - Steeply slanted groove

7 - Gently slanted groove

8 - Center block

9 - Block

10 - Center sipe

11, 12, 13, 15 - Sipe

14 - Shoulder block /6

16 - Lead narrow portion

TE - Tread ground touching edge

Figure 1

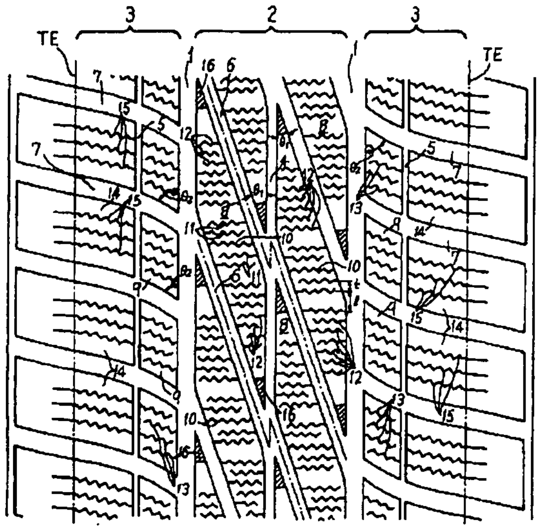
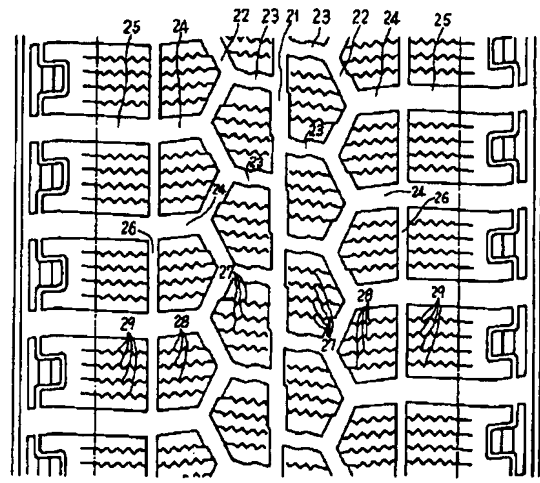


Figure 2



PTO 07-6290

CC = JP
19940517
Kokai
06135207

PNEUMATIC RADIAL TIRE
[Kuukiiri rajiaru taiya]

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UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. AUGUST 2007
TRANSLATED BY: THE MCELROY TRANSLATION COMPANY

PUBLICATION COUNTRY	(19):	JP
DOCUMENT NUMBER	(11):	06135207
DOCUMENT KIND	(12):	Kokai
PUBLICATION DATE	(43):	19940517
APPLICATION NUMBER	(21):	04288943
APPLICATION DATE	(22):	19921027
INTERNATIONAL CLASSIFICATION[5]	(51):	B 06 C 11/11
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APPLICANT	(71):	Otsu Tire Co., Ltd.
TITLE	(54):	PNEUMATIC RADIAL TIRE
FOREIGN TITLE	[54A]:	Kuukiiri rajiaru taiya

Claim

A type of pneumatic radial tire characterized by the following facts: pneumatic radial tire (10) has straight grooves (19L), (19R) that are substantially continuous in the circumferential direction to the left/right of tread portion (15) of the block pattern;

said straight grooves (19L), (19R) on the left/right sides on ground contact surface (20) of tread portion (15) are composed of left/right groups of edges (23L), (23R), (24L), (24R) of plural blocks (21L), (21R), (22L), (22R) set in the circumferential direction; a group of edges (23L), (24L) among left/right groups' edges (23L), (23R), (24L), (24R) fit edges (25L), (25L) of rain-grooved road surface (25), while the other group's edges (23L), (24L) have the phase shifted in the tire's axial direction.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to a type of pneumatic radial tire. Especially, the present invention pertains to a type of pneumatic radial tire fit for high speed running.

[0002]

Prior art

In the recent years, due to completion of the highway network and technical innovation of sedans, it has become possible to perform stable running at an ultrahigh speed over 150 km/h. In company with this, there is a demand for development of a type of tire with sufficiently good performance at a very high speed, that is, with excellent water-dispersing property and resistance to uneven wear, as well as good turning performance.

[0003]

For the tire for high speed running, it is important to guarantee both the wet performance in straight movement or turning on a wet road surface, depending mainly on the water-dispersing property, and the dry performance represented by the steering stability on a dry road surface. For this purpose, as shown in Figures 3 and 4, there has been proposed a type of pneumatic radial tire having a tread portion with a block pattern (including block rib pattern).

[0004]

The tire shown in Figure 3 has rib (2) that stretches linearly in the circumferential direction at the center of tread portion (1). To the left/right of rib (2), side block (3) and shoulder block (4) as a pair are divided by straight groove (5) that stretches linearly and substantially continuous in the circumferential direction. The tire shown in Figure 4 has rib (2) that stretches linearly in the circumferential direction at the center of tread portion (1). To the left/right of said rib (2), side block (3) and shoulder block (4) are set in the circumferential direction and divided by straight groove (5) that stretches linearly and substantially continuously in the circumferential direction shape.

[0005]

Problems to be solved by the invention

In the prior art shown in Figures 3 and 4, as it has straight groove (5), the wet performance is good. Regarding the dry performance (steering stability, wandering performance), for the first example of the prior art, as shown in Figure 3, edges (3A) are formed individually in taper shape with respect to the circumferential direction only on each outer side of side block (3). For the second example of the prior

art, as edge (4A) of the shoulder block is formed in an arc shape, the wandering performance is improved.

[0006]

However, on the so-called rain-grooved road surface with rain grooves formed on the surface of a highway, etc., there are many buffering portions between edge (6) of the rain grooves and ground contact surface (7) of side block edge (3A) or shoulder block edge (4A). As the buffering degree is high, the wandering performance is adversely influenced. The objective of present invention is to provide a scheme that can improve the wandering performance while guaranteeing the wet performance by providing little chance for buffering between the block edge and the rain groove edge.

[0007]

Means to solve the problems

In order to realize the aforementioned objective, the present invention provides a type of pneumatic radial tire characterized by the following facts: pneumatic radial tire (10) has straight grooves (19L), (19R) that are substantially continuous in the circumferential direction on the left/right of tread portion (15) of the block pattern; said straight grooves (19L), (19R) on the left/right sides on ground contact surface (20) of tread portion (15) are composed of left/right groups of edges (23L), (23R), (24L), (24R) of plural blocks (21L), (21R), (22L), (22R) set in the circumferential direction; a group of edges (23L), (24L) among left/right groups' edges (23L), (23R), (24L), (24R) fit edges (25L), (25L) of rain-grooved road surface (25), while the phase of the other group's edges (23L), (24L) is shifted in the tire's axial direction.

[0008]

Operation

For the tire of the present invention, when the tires are installed on an automobile for running on a rain-grooved road surface, the water-dispersing performance is guaranteed by the left/right straight grooves (19L), (19R). A group of edges (23L), (24L) among left/right groups' edges (23L), (23R), (24L), (24R) fits edges (25L), (25L) of the rain-grooved road surface on ground contact surface (20), while the phase of the other group's edges (23L), (24L) is shifted in the tire's axial direction. Consequently, there is little chance for impact between road surface edges (25L), (25L) and block edges (23L), (24L) (chance of impact). As a result, the wandering performance is improved.

[0009]

Application examples

In the following, an explanation will be given regarding application examples of the present invention with reference to figures. As shown in Figure 2, for pneumatic radial tire (10), bead cores (12) are buried in a left/right pair of bead portions (11). On one bead core (12), radial carcass (13) is wound up. On its other end, it is wound on said other bead core (12). (13A) illustrates the two wind-up portions.

[0010]

Also, pneumatic radial tire (10) has a pair of left/right sidewall portions (14) and tread portion (15) connected with a toroidal cross-sectional shape. In tread portion (15), there is belt layer (16). Left/right bead portions (11) having bead filler (17) are fit on rim (18). As shown in Figure 1, tread portion (15) is block-patterned, and it has straight grooves (19L), (19R) that are substantially continuous in the circumferential direction on the left/right sides.

[0011]

Also, here, as the block pattern, there is a rib block pattern. In addition to the two straight grooves shown in the figure, there may be third, fourth, and other straight grooves. Straight grooves (19L), (19R) on the left/right sides of ground contact surface (20) of tread portion (15) are composed of left/right groups of edges (23L), (23R), (24L), (24R) of plural blocks (21L), (21R), (22L), (22R) set in the circumferential direction. Each block is composed of center block group (121) and shoulder block group (122). Said center block group (121) is composed of first block (121A) with a ground contact surface in vertical trapezoidal shape in the plan view, second block (121B) with a ground contact surface in elongated trapezoidal shape in the plan view, third block (121C) with a ground contact surface in inverted L shape in the plan view, fourth block (121D) with a ground contact surface in lozenge shape in the plan view, and fifth block (121E) with a ground contact surface in L shape in the plan view. While fourth block (121D) is set at the center of the tread, first block (121A) is set detouring one of straight groove (19R) and (19L), and fifth (121E) is set on the side of the other of said straight groove (19R) and (19L), and the first-fifth (121A)-(121E) are set in the circumferential direction.

[0012]

Said shoulder block group (122) has first-fourth blocks (122A)-(122D), which have a ground contact surface in elongated trapezoidal shape in the plan view, set with spacing between them in the circumferential direction. The portions that form straight grooves (19L), (19R) on ground contact surface (20) include, on the L-side (the same on the R-side), edges (23L), (24L) of the left/right groups of first-third blocks (121A), (121C) among center block group (121) and first-fourth blocks (122A)-(122D) of shoulder block group (122). Among edges (23L), (24L) of the left/right groups with

respect to edges (25L), (25L) of rain-grooved road surface (25) (or edges (23R), (24R) on the R-side), for a group of edges (23L), (24L), the edge of first shoulder block (122A) and the edge of first center block (121A) are fit. For edges (23L), (24L) of the other group, in this application example, the edges of second-fourth shoulder bocks (122B)-(122D) and the edges of the second-third center blocks (121B), (121C) have a taper in the tire's axial direction of about 2° indicated by angle θ, as they are set in the circumferential direction with the phase shifted from the straight groove group.

[0013]

Also, as explained above, in center block group (121), as first-fifth blocks (121A)-(121E) are set in the circumferential direction, in principal groove (26), continuous in the oblique direction, too, by setting block edges at an inclined angle θ1 of about 15° with respect to the center line, in center block group (121), too, only one group of edges are buffered to the rain groove edges of ground contact surface (20), so that the wandering performance is improved.

[0014]

In said application example, in addition to the block pattern shown in the figure, one may also adopt the patterns shown in Figures 3 and 4, with a principal groove formed in zigzag shape at the tread center.

[0015]

Effects of the invention

According to the present invention with the aforementioned constitution, due to the straight grooves formed in the tread portion, the water-dispersing property is improved. At the same time, the wandering performance of the rain grooves in the straight grooves is excellent.

Brief description of the figures

Figure 1 is a developed view illustrating the block pattern pertaining to an application example of the present invention.

Figure 2 is a cross-sectional view illustrating the tire of the present invention.

Figure 3 is a developed view of the block pattern in a first example of the prior art.

Figure 4 is a developed view of the block pattern in a second example of the prior art.

Explanation of symbols

10	Tire
15	Tread portion
19L	Straight groove
19R	Straight groove
20	Ground contact surface
21L	Block
21R	Block
22L	Block
22R	Block
23L	Block edge
23R	Block edge
24L	Block edge
24R	Block edge
25	Rain-grooved road surface

25L Edge of rain-grooved road surface

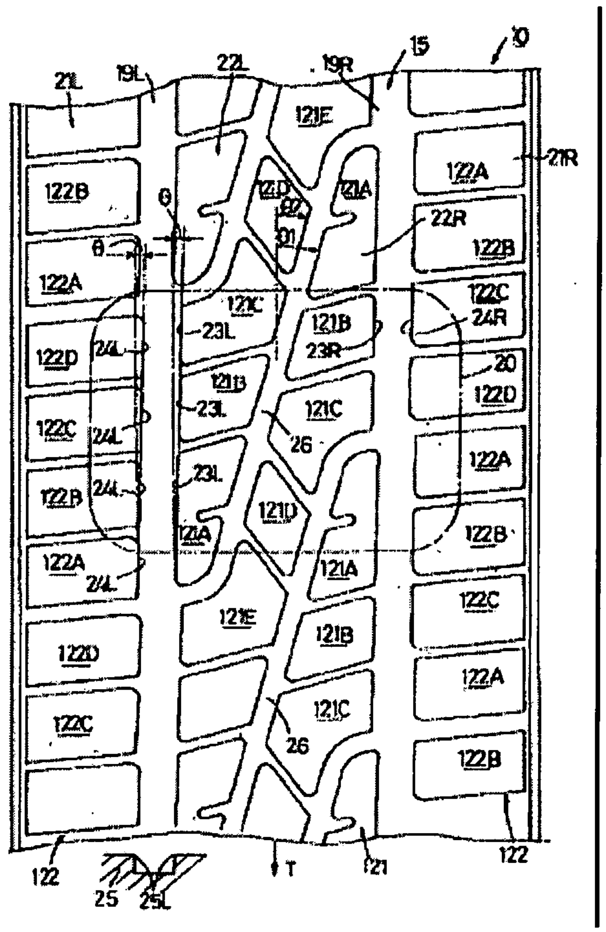

Figure 1

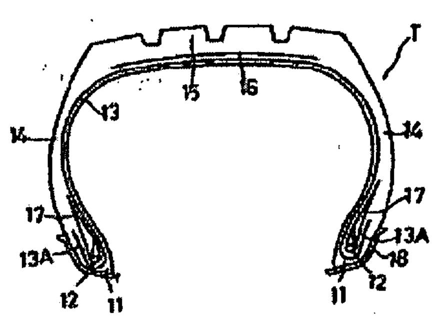

Figure 2

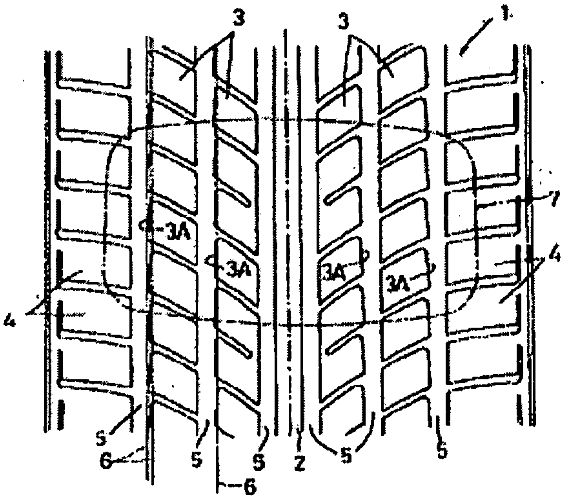

Figure 3

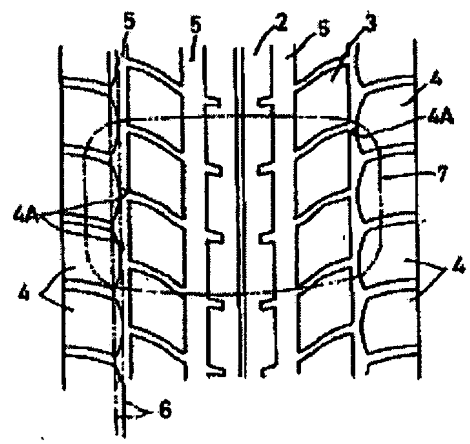

Figure 4

PTO 07-6149

CC=DE
DATE=1935063
KIND=Patent
PN=614574

ELASTIC TIRE FOR MOTORCARS, BICYCLES AND OTHER VEHICLES
[ELASTISCHER RADREIFEN FÜR KRAFTFAHRZEUGE, FAHRRÄDER UND ANDERE FAHRZEUGE]

GOTTFRIED KIEWITT

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C.
AUGUST 2007
TRANSLATED BY SCHREIBER TRANSLATION, INC.

PUBLICATION COUNTRY	(10):	Germany
DOCUMENT NUMBER	(11):	614574
DOCUMENT KIND	(12):	Patent
PUBLICATION DATE	(43):	13th June 1935
APPLICATION NUMBER	(21):	
APPLICATION DATE	(22):	
INTERNATIONAL CLASSIFICATION	(51):	
PRIORITY COUNTRY	(33):	
PRIORITY NUMBER	(31):	
PRIORITY DATE	(32):	
INVENTOR(S)	(72):	Gottfried Kiewitt, Hamburg, Germany
APPLICANT(S)	(71):	
DESIGNATED CONTRACTING STATES	(81):	
TITLE	(54):	ELASTIC TIRE FOR MOTOR CARS, BICYCLES AND OTHER VEHICLES
FOREIGN TITLE	[54A]:	ELASTISCHER RADREIFEN FÜR KRAFTFAHRZEUGE, FAHRRÄDER UND ANDERE FAHRZEUGE

The invention relates to other effective arrangements and developments of treads which are arrow shaped and in slant direction between the prism surfaces of the type protected according to patent 599409. These prism surfaces run between the sides of the tire. It refers to the enlargement of shock absorbing area of each prism surface through its elongation on the width of treads and the development of long sides of prism surfaces as effective resistance edges for increasing the road adhesion and increasing the road safety.

The drawing shows some examples of the invention in Figs. 1 to 14.

Fig. 1 shows a sectional view of the course of a linear prism surface 5.

Fig. 2 shows a working profile in top view and sectional view. The prism surfaces 5 that are held vertical between the edges 4 run in the slanting direction between the sides of tire. One of the prism surfaces is shown as dotdashed. The prism surfaces are separated from each other through cascaded grooves 10. The long sides of the prism surfaces lie free and protrude such that the edge part causes

increased antifriction resistance on its entire length; this edge part is formed from the supporting surface of each prism surface and their sides. The cross-section of tread shows the radially different heights of supporting prism surfaces 5.

Fig. 3 shows a side view of prism surface 5 of Fig. 2; this prism surface runs horizontal between the prism edges 4 and is tangent to the pitch circumference 1.

Fig. 4 shows a sectional view of a straight prism surface 6, 7 that runs uphill from the tire sides to the middle of tire against a cylindrical band 8 with ring grooves 9.

Fig. 5 shows a top view of arrow-shaped prism surfaces 6,7 that are arranged along with a cylindrical ring band 8 and ring groove 9; these surfaces are adjacent to each other in their centre of elongation and are separated from each other spheroidal in shape by the grooves 10 which expand towards the prism edges 4. One of the prism surfaces 6, 7 is shown with dotdashed line. The sectional image transverse to the tire shows one of the supporting prism surfaces 6,7 whose height position changes during the running and the sectional view also shows the ring band 8.

Fig. 6 shows a side view of a prism surface 6, 7 of Fig. 5. It runs linear between the edges 4 and it goes a little

uphill towards the outside from the tire side to the centre of the tire. All edges 4 of adjacent prism surfaces are shown by points in the circles circumscribed by the prism edges; these edges project outwards over a prism surface 6,7.

/2

Fig. 7 shows a section transverse to the working profile; this section shows the course of the prism surface 11, 12 which runs between three ring bands 8 with ring grooves 9 going uphill outwards from the tire edges to the middle of the tire in a slightly arch-shape.

Fig. 8 shows a top view of the prism surfaces 11, 12; these surfaces are separated equidistant from each other in a linear fashion on the tread with the help of grooves 10; they run arrow-shaped from the tire sides to the middle of tire between the three cylindrical ring bands 8 with ring grooves 9. The section transverse to the working profile shows one of many different height positions of the supporting prism surfaces 11, 12. One of the prism surfaces 11, 12 is shown with dotdashed lines.

Fig. 9 is a prism surface 11, 12 of Fig. 8 which runs towards the outside from edge 4 to edge 4 in a flat arch shown in side view; this arch has a radius which is a multiple of radius of pitch circumference.
Fig. 10 shows the course of the slightly arch-shaped prism surface 11, 12 of Figs. 8 and 9 in side view. The prism surfaces 11 that run uphill towards the outside in an arch-shape between the cylindrical ring bands 8 that are largely different in diameter, are placed alternatingly for better recognition of the edges of their long prism sides; these edges lie freely opposite to the adjacent prism surfaces. Thus, the resistance edges of the prism surfaces are shown along with the edges 4 through the long prism sides with their apex parts 2, 3 projecting outwards. These resistance edges reach beyond the width of tire. They are used as a means of increasing the road adhesion.

Figs. 11 and 12 show the sectional view and side view of prism surfaces 12 which are slightly bent towards the outside in a linear fashion and they lie only with their edges and with their centre in a circular arc. This arc has a radius which is a multiple of radius of pitch circumference.

Figs. 13 and 14 are sections and side views of such prism surfaces 13 which are slightly uphill towards the outside in a linear fashion and lie only with their edges and with peak outside the centre of elongation in a circular arc. This arc has a radius which is a multiple of radius of pitch circumference.

The long prism surface sides can be held even in other effective shapes, especially arch-shaped, other than cascaded or linear form as shown in top view. The edges 4 can be held through wear-resistant material and with larger widths.

In order to be able to pass through the unevenness, the length and numerous arrow-shaped or slanting prism surfaces protect the wheel and the vehicle not only against the effects of harmful vertical movements, but the long sides of prism surfaces give a better and maximum grip to the tires as abrasive- and resistance edges on uneven as well as even, dry and wet slippery roads. Thus, the potholes on roads are better crossed and thus, made more ineffective due to increased supporting effects.

Patent claims:

1. Elastic tire for motor cars, bicycles and other vehicles with treads divided into numerous prism surfaces according to patent 599 409, characterized thereby, that the prism surfaces run arrow-shaped from the edges of tire to the centre of the tread.
2. Elastic tire according to Claim 1, characterized thereby, that the prism surfaces run in the slant direction between the sides of tires.
3. Elastic tire according to Claim 2, characterized thereby, that the side edges of prism surfaces run in a cascaded shape.
4. Elastic tire according to Claim 1, characterized thereby, that the prism surfaces which run together towards the centre in the top view go uphill in the side view from the edges of wheel to the centre of wheel (Figs. 6 and 9).

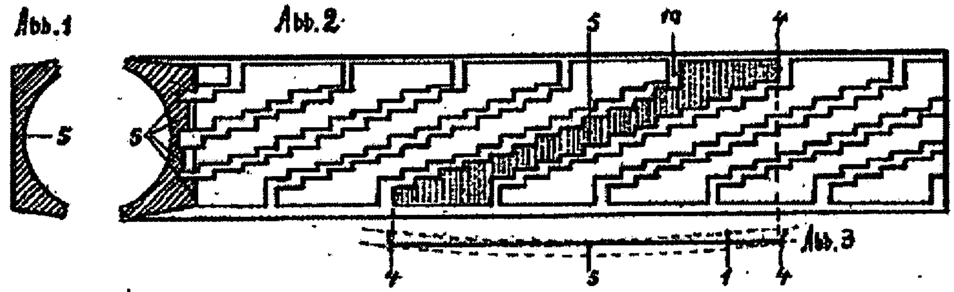

Abb.1
Abb.2
Abb.3
5
10
4
1

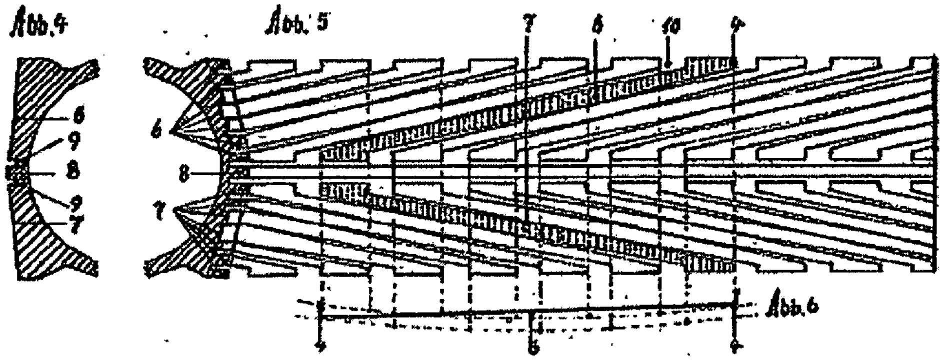

Abb.4
Abb.5
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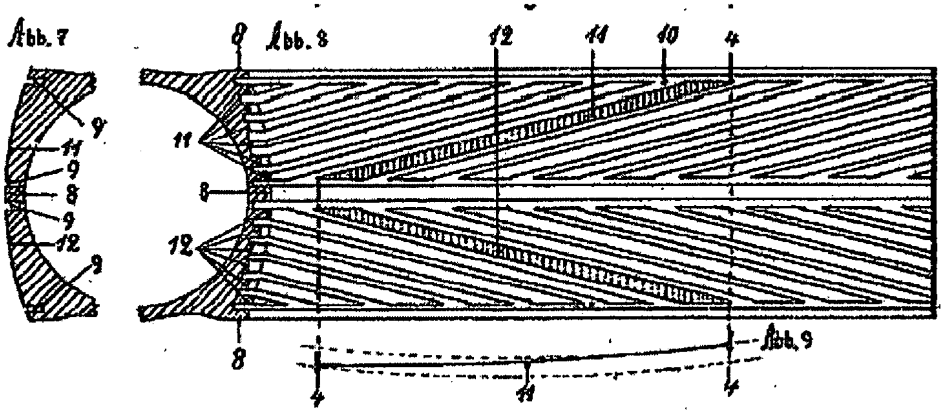

Abb.7
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Abb.10


Abb.11

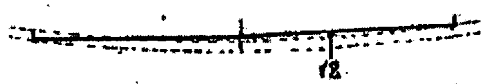

Abb.12


Abb.13

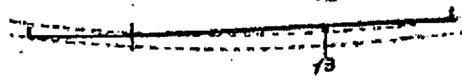

Abb.14

PTO 07-6302

CC = JP
19900213
Kokai
02041907

PNEUMATIC TIRE FOR SEDANS
[Joyosha yo kukiiri taiya]

Kenichi Shirai et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. AUGUST 2007
TRANSLATED BY: THE MCELROY TRANSLATION COMPANY

PUBLICATION COUNTRY	(19):	JP
DOCUMENT NUMBER	(11):	02041907
DOCUMENT KIND	(12):	Kokai
PUBLICATION DATE	(43):	19900213
APPLICATION NUMBER	(21):	63189642
APPLICATION DATE	(22):	19880730
INTERNATIONAL CLASSIFICATION[5]	(51):	B 60 C 11/11
INVENTOR(S)	(72):	Kenichi Shirai, et al.
APPLICANT(S)	(71):	Yokohama Rubber Co. Ltd.
TITLE	(54):	PNEUMATIC TIRE FOR SEDANS
FOREIGN TITLE	[54A]:	Joyosha yo kukiiri taiya

Claim

A type of pneumatic tire for sedans characterized by the following facts: the tire has blocks in different lengths in the tire circumferential direction set as a configuration on the periphery of the tire; the length of two blocks having different lengths in the tire circumferential direction of said block sequence is taken as a pitch; the tread pattern is composed of at least three types of pitches in different pitch lengths; the blocks are set sequentially in rising order of the ratio of the circumference of the larger block to that of the smaller block of the pitch; at the same time, the order in setting the pitches of the block sequence that forms the center side is opposite (inverted) to that of the adjacent shoulder side, and the ratio of the maximum pitch to the minimum pitch is in the range of 1.2-1.6.

Detailed explanation of the invention

Industrial application field

The present invention pertains to a type of pneumatic tire for sedans (hereinafter to be referred to as tire) characterized by the fact that it has a tread pattern which can reduce the pattern noise without decrease in cornering power.

Prior art

The noise generated by a tire in running is usually called pattern noise, which is mainly affected by the tread pattern. In order to reduce the noise caused by the tread pattern, people have proposed many schemes. For example, according to one scheme, the tire has the pitch configuration in variation or has the pitches in different lengths. However, for said tires, there is still no way to meet the demand on the characteristics for practical applications without deterioration of other tire performance [characteristics], especially wear resistance and/or cornering power, while the pattern noise is reduced.

Problems to be solved by the invention

The purpose of the present invention is to solve the aforementioned problems of the prior art by providing a type of pneumatic tire for sedans characterized by the fact that it can reduce said pattern noise without decreasing cornering power and single-side wear resistance.

Means to solve the problems

The present invention provides a type of pneumatic tire for sedans characterized by the following facts: the tire has blocks in different lengths in the tire circumferential direction set as a configuration on the periphery of the tire; the length of two blocks having different lengths in the tire circumferential

direction of said block sequence is taken as a pitch; the tread pattern is composed of at least three types of pitches in different pitch lengths; the blocks are set sequentially in rising order of the ratio of the circumference of the larger block to that of the smaller block of the pitch; at the same time, the order in setting the pitches of the block sequence that forms the center side is opposite (inverted) to that of the adjacent shoulder side, and the ratio of the maximum pitch to the minimum pitch is in the range of 1.2-1.6.

Figure 1 is a plan view illustrating an example of the tread pattern of the tire of the present invention. As shown in the figure, this tread pattern is composed of block sequences (ribs) (2_1), (2_2), (2_3), (2_4), (2_5) divided by plural longitudinal grooves (1) extending along center line CL of the tire and lateral grooves (3) in the direction crossing said longitudinal grooves (1). For the block sequences on the tire of the present invention, the length of two blocks (4_a), (4_b) with different lengths (a), (b) in the circumferential direction of the tire is taken as a pitch, and three types of pitches (A), (B), (C) with different pitch lengths are used to form the block sequence. That is, pitch (A) is composed of two blocks with different lengths along the tire's circumferential direction a_1 and b_1, respectively. On the other hand, pitch (B) is composed of two blocks with different lengths along the tire's circumferential direction a_2 and b_2, respectively, and pitch (C) is composed of two blocks with different lengths along the tire's circumferential direction a_3 and b_3, respectively.

For said pitches (A), (B), (C), the ratio of the circumference of the larger block to that of the smaller block in each pitch is larger for the pitch with larger size, and smaller for the pitch with smaller size. The reason is as follows: for the pitch with smaller size, if said block ratio is selected to be large, the size of the smaller block becomes too small, so that one-side wear or the like can take place easily. On the other hand, for the pitch with a larger size, if said block ratio is too large, the larger block becomes too large to have an appropriate balance with the smaller block, so that one-side wear or the like is also likely to take

place. Consequently, the ratio of the circumference of the larger block to that of the smaller block in each pitch should be about 1.6 for the larger pitch, and about 1.2 for the smaller pitch.

In addition, the ratio of the maximum pitch length (A in the figure) to the minimum pitch length (C in the figure) that form the pitch should be in the range of 1.2-1.6.

If said ratio is smaller than 1.2, the effect in reducing the noise becomes less significant. On the other hand, if said ratio is over 1.6, the block rigidity becomes unbalanced, and one-side wear is apt to take place, and this too is undesired.

In addition, as shown in Figure 1, said pitch configuration is set in the rising order of the ratio of the circumference of the larger block to that of the smaller block of the pitch that form the pitch, and the order in setting the pitches of the block sequence that forms the center side should be opposite (inverted) to that of the adjacent shoulder side. Since the order in setting the pitches of the block sequence that forms the center side is opposite that of the shoulder side, it is possible to prevent concentration of the pattern noises in a single frequency band, so that it is possible to reduce the pattern noise level. Also, it is possible to eliminate the imbalance in the block rigidity, and to prevent decrease in the cornering power. In order to prevent decrease in the cornering power, larger blocks (4_a), (4_a) of the block sequences (ribs) on said adjacent center side and shoulder side (or smaller blocks (4_b), (4_b)) should be set such that they alternately cross each other.

Also, for the tire of the present invention, in order to prevent generation of noises and to improve the effect in preventing one-side wear, the lateral groove angle θ (Figure 1) is preferably in the range of 50°-70°. Also, for the tire of the present invention, there is no specific restriction on the number, shape, width, depth, etc., of the longitudinal grooves extending in the tire's circumferential direction or on the lateral grooves crossing them.

In the following, an explanation will be given regarding the effects of the present invention more specifically, with reference to application examples.

Here, the noise level is evaluated using the following measurement method.

Noise level:

The indoor single-member noise is measured according to JASO C 606 under the following conditions.

Pneumatic pressure: 2.10 kgf/cm^2, load: 400 kg, rim: 6.5-JJx15.

<u>Application Examples 1-2, Comparative Examples 1-3</u>

Tires with tire size of 205/65R15 (tires of the present invention) were prepared under the following conditions: as shown in Figure 1, the tread pattern has a pitch sequence of ribs (block sequences) (2_1), (2_2), (2_3) and (2_4) with the following features: the ratio of the maximum pitch length to the minimum pitch length (pitch length A/pitch length C) is 1.33; pitch lengths and ratio of the circumference of the larger block to that of the smaller block for pitches A, B, C are listed in the following table. Each tire was installed on a rim of 6.5-JJx15, and said noise level was measured.

Also, tires (conventional tires) were prepared in the same way as in the present invention, except that the block lengths in each pitch are the same (the ratio of the circumference of the larger block to that of the smaller block is 1.00). Also, the noise level was measured, with results shown in Figure 2.

2_1:

(Aa · Ab, Ba · Bb, Ca · Cb, Ba · Bb, Aa · Ab) 、

2_2:

(Ab · Aa, Bb · Ba, Cb · Ca, Bb · Ba, Ab · Aa) 、

2_3:

(Aa · Ab, Ba · Bb, Ca · Cb, Ba · Bb, Aa · Ab)

and

2_4:

(Ab · Aa, Bb · Ba, Cb · Ca, Bb · Ba, Ab · Aa) 。

As can be seen from the figure, the noise level of the tires of the present invention is lower than that of the conventional tires over the entire speed range.

2

1	ピッチ長 A 55.2	ピッチ長 B 48.5	ピッチ長 C 41.5
大ブロック長 小ブロック長	34.2 21.0	28.5 20.0	22.5 19.0
大／小 ブロック長比	1.63	1.43	1.18

Key: 1 Length of larger block

Length of smaller block

A/C

Ratio of length of the larger block to the smaller block

2 Pitch length

Effects of the invention

According to the present invention, by means of the constitution composed of two blocks with different sizes as each pitch, it is possible to increase the types of the pitches substantially, so that it is possible to avoid concentration of pattern noises to a single frequency band, and it is possible to reduce the noise level. Also, by setting the pitches that form the pattern of the tire of the present invention in the rising order of the ratio of the circumference of the larger block to that of the smaller block of the pitch, and by setting the pitches of the block sequence that forms the center side opposite (inverted) to that of the adjacent shoulder side, the larger/smaller blocks of the block sequences (ribs) on the adjacent center side and shoulder side cross each other, so that it is possible to prevent the pattern noises from concentrating in the same frequency band. That is, it is possible to have the noises dispersed, so that it is possible to further reduce the noise level. In addition, it is possible to eliminate the imbalance of the block rigidity, so that it is possible to prevent decrease in the cornering power.

Brief description of the figures

Figure 1 is a plan view illustrating an example of the tread pattern of the tire of the present invention. Figure 2 is a graph illustrating the relationship between the running speed and the noise level in the tire noise test.

4	Block
A, B, C	Pitch
a_1, b_1, a_2, b_2, a_3, b_3	Lengths of blocks that form pitches A, B, C in the tire's circumferential direction

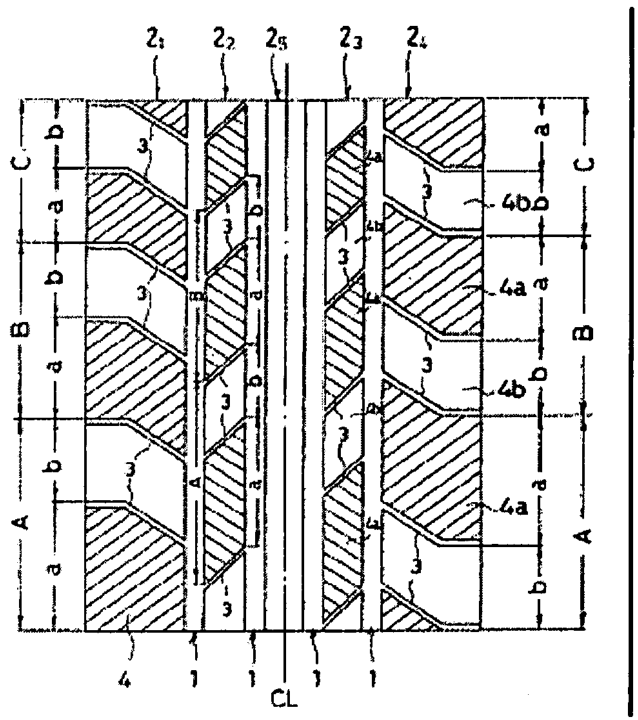

Figure 1

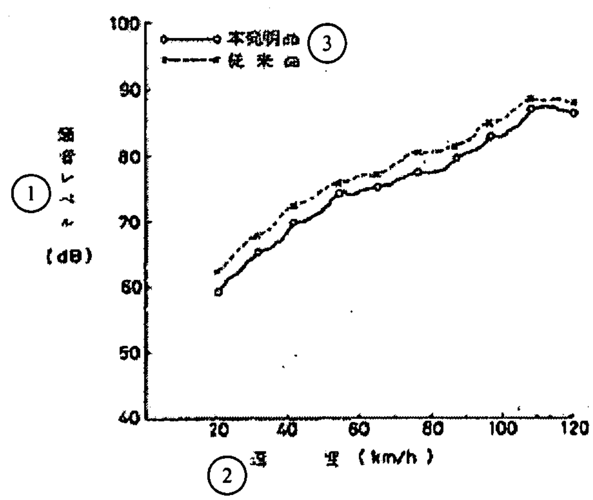

Figure 2

Key: 1 Noise level (dB)

2 Speed (km/h)

3 Tires of the present invention

Tires of prior art

PTO 07-6289

CC = JP
19900712
Kokai
02179508

PNEUMATIC TIRE
[Kuukiiri taiya]

Susumu Watanabe et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. AUGUST 2007
TRANSLATED BY: THE MCELROY TRANSLATION COMPANY

DOCUMENT NUMBER	(11):	02179508
DOCUMENT KIND	(12):	Kokai
PUBLICATION DATE	(43):	19900712
APPLICATION NUMBER	(21):	63331431
APPLICATION DATE	(22):	19881229
INTERNATIONAL CLASSIFICATION	(51):	B 60 C 11/11
INVENTOR(S)	(72):	Susumu Watanabe et al.
APPLICANT(S)	(71):	Yokohama Rubber Co., Ltd.
TITLE	(54):	PNEUMATIC TIRE
FOREIGN TITLE	[54A]:	Kuukiiri taiya

Claim

A pneumatic tire characterized in that in a pneumatic tire having a block-based thread pattern on its tread, at least the edge parts of the blocks are chamfered along nearly the entire circumference of said blocks, and said chamfer angle is set at 5-30° with respect to the tread.

Detailed explanation of the invention

Industrial application field

The present invention pertains to a pneumatic tire with which noises and rolling resistance can be reduced during the initial wear (traveling distance of approximately 6000 km) of a new product, and operational stability and abrasion resistance can be improved.

Prior art

As shown in Figure 8, in the case of a pneumatic tire having a block-based thread pattern, major grooves 2 are formed on its tread 1 in circumferential direction EE' of the tire, and minor grooves 3 are formed in width direction FF' of the tire so as to form blocks 4 and ribs 5. However, as shown in the enlarged cross-sectional view along A-A in Figure 8 that is shown in Figure 9, because edge parts 6 of said blocks 4 and ribs 5 are sharp, following problems ①-④ are created. Furthermore, said problems are salient when the tire is new and during the period of its initial wear, and they are reduced gradually as it gets worn.

① Because the tread and the edge parts come into contact abruptly as the tire rotates, and the edge parts vibrate when stepped in and when kicked out, high-frequency noises are generated. ② Because the edge parts are deformed significantly when stepped in, a large amount of heat is generated, and thus the rolling resistance increases. ③ When a force is applied to the blocks in the width direction of the tire during cornering, or when a force is applied to the blocks in the circumferential direction of the tire during braking, stresses are concentrated near the edge parts, and the other parts become unable to operate effectively, resulting in poor operational stability. ④ Because the rigidity at the edge parts is low, the difference in the amount of friction between the step-in side and the kick-out side increases, so that partial wear is likely to occur, and noise increases during travel as a result.

Problem to be solved by the invention

The present invention was made in order to solve the aforementioned problems, and its purpose is to present a pneumatic tire for which shapes of blocks and ribs on the tire thread are designed to reduce noise and rolling resistance while improving operational stability and abrasion resistance.

Means to solve the problem

The gist of the present invention refers to a pneumatic tire characterized in that in a pneumatic tire having a block-based thread pattern on its tread, at least the edge parts of the blocks are chamfered along nearly the entire circumference of said blocks, and said chamfer angle is set at 5-30° with respect to the tread.

Said means will be explained in detail below with reference to figures. Here, the same positions and components in Figure 8 and Figure 9 are indicated using the same numbers.

Figure 1 is a plan view illustrating an example tread pattern of the pneumatic tire of the present invention. In Figure 1, major grooves 2 are formed on tread 1 in circumferential direction EE' of the tire, and minor grooves 3 are formed in width direction FF' of the tire so as to form blocks 4 and ribs 5. As shown in the enlarged cross-sectional view along B-B in Figure 1 that is shown in Figure 2, edge parts 6 are chamfered. As shown in Figure 1, said chamfer is applied along nearly the entire circumference of said blocks 4.

In addition, chamfer angle α is 5-30°, or preferably, 10-20°. Here, chamfer angle α refers to an angle formed with respect to the tread of the tire. If chamfer angle is less than 5°, hardly any chamber effect is demonstrated. On the other hand, because the rigidity of the blocks drops if it exceeds 30°, operational stability becomes insufficient.

Chamfer depth is 0.2-2.0 mm, or preferably, 0.6-1.4 mm or so.

While it is desirable that both the blocks and the ribs are chamfered in said manner, at least the blocks should be chamfered. 50% or more of the blocks on tread 1 should be chamfered. It is particularly desirable that all of the blocks formed at the shoulder parts of tread 1 be chamfered in order improve the rolling resistance and the operational stability during cornering.

When traveling using the tire with said chamfered block-based tread pattern, as shown in Figure 3, because the surfaces of blocks 4 and the surfaces at edge parts 6 come into contact with road surface M smoothly as the tire rotates in the rotating direction indicated by arrow T, no vibrations are created, so that noises are reduced, and the rolling resistance is reduced also. In addition, even when force S is applied to blocks 4 in the width direction or in the circumferential direction of the tire during cornering or braking as shown in Figure 4(A), because edge part 6 comes into contact with road surface so as to receive said force S as shown in Figure 4(B), the operational stability is improved, and partial wear is reduced. To the contrary, in the case of the conventional tire with the block-based tread pattern shown in Figure 8 and Figure 9, as the tire rotates in the rotating direction indicated by arrow T as shown in Figure 6, edge part 6 of block 4 comes into contact with road surface M abruptly, more noise is generated, and the rolling resistance increases. Then, when force S is applied to block 4 in the width direction or the circumferential direction of the tire during braking as shown in Figure 7(A), because edge part 6 comes into contact with road surface M so as to receive said force S only at the narrow part, the operational stability deteriorates, and partial wear increases.

An application example will be shown below.

Application example

Noise levels were evaluated of the tire of the present invention and the conventional tire when they were new. The results are shown in Figure 5. In addition, rolling resistance, difference in partial wear within 1 block, and operational stability were evaluated, respectively. The results are shown in Table 1.

(1) Tire of the present invention

Tire size is 205/60 R15. It has the block-based tread pattern shown in Figure 1 and Figure 2. Chamfer angle $\alpha = 15°$. Chamfer depth h = 1.0 mm. All blocks on the tread are chamfered.

(2) Conventional tire

Tire size is 205/60 R15. It has the block-based tread pattern shown in Figure 8 and Figure 9.

<u>Method for evaluating noise level</u>:

The tire of the present invention and the conventional tire were installed as front wheels of a domestic FR car, and vehicular noises were measured (at the measuring speed of 80 km/h) inside the cabin at every 2000 km and evaluated in terms of relationship between traveling distance and sound pressure level. The results are shown in Figure 5. In Figure 5, a corresponds to the conventional tire, and b corresponds to the tire of the present invention. It is clear from Figure 5 that the tire of the present invention shows a significant drop in the noise level during the period when it is new to the initial stage of wear.

<u>Method for evaluating rolling resistance</u>:

Rolling resistance values when they were new were measured using a rolling resistance tester. The results are shown in the form of indices. The higher the value is, the better [the performance] is.

<u>Method for evaluating partial wear within 1 block</u>

Difference in partial wear was measured for evaluation after having traveled on an ordinary street for 6000 km at the average speed of 30 km/h. The higher the value is, the better [the performance] is.

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TABLE 1

1	従来タイヤ	本発明タイヤ 2
3 転がり抵抗（指数）	100	104
1ブロック内摩耗量差（mm）	0.5	0.3
操縦安定性フィーリング評価点	2.5	2.8

Key: 1 Conventional tire

2 Tire of the present invention

3 Rolling resistance

Difference in partial wear within 1 block (mm)

Evaluation score of operational stability by the feel

It is clear from Table 1 that the tire of the present invention is superior in terms of rolling resistance, partial wear, and operational stability.

Effect of the invention

As explained above, according to the present invention, because at least the edge parts of the blocks are chamfered along nearly the entire circumference of said blocks, and said chamfer angle is set at 5-30° with respect to the tread, noise (noise during the initial wear of a new product) and rolling resistance can be reduced, and operational stability and partial wear can be improved.

Brief description of the figures

Figure 1 is a plan view illustrating an example treat pattern of the pneumatic tire of the present invention.

Figure 2 is an enlarged cross-sectional view along B-B thereof.

Figure 3 is a diagram illustrating the condition when the pneumatic tire of the present invention comes into contact with the ground as it rotates.

Figures 4(A) and (B) are diagrams illustrating the condition of the pneumatic tire of the present invention when a force is applied in the width direction.

Figure 5 is a diagram showing the relationship between traveling distance and sound pressure level.

Figure 6 is a diagram illustrating the condition of a conventional pneumatic tire when it comes into contact with the ground as it rotates.

Figures 7(A) and (B) are diagrams illustrating the condition of the conventional pneumatic tire when a force is applied in the width direction.

Figure 8 is a plan view illustrating an example tread pattern of the conventional pneumatic tire.

Figure 9 is an enlarged cross-sectional view along A-A thereof.

1 … tread; 2 … major groove; 3 … minor groove; 4 … block; and 5 … side part of block.

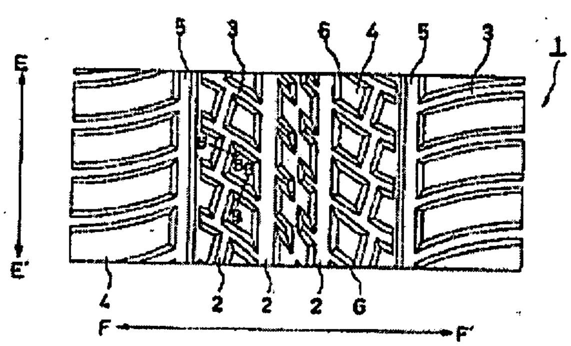

Figure 1

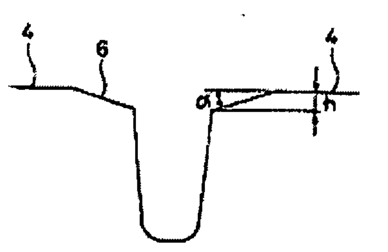

Figure 2

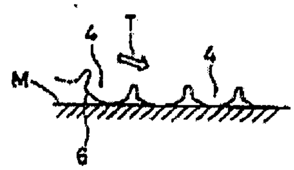

Figure 3

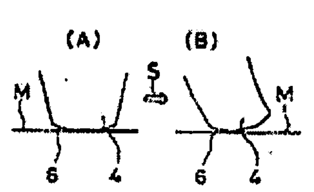

Figure 4

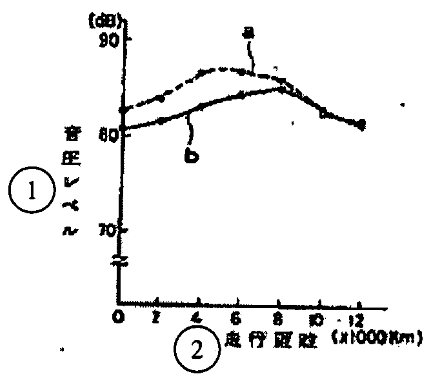

Figure 5

Key: 1 Sound pressure level

2 Traveling distance

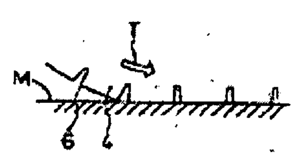

Figure 6

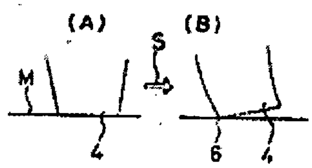

Figure 7

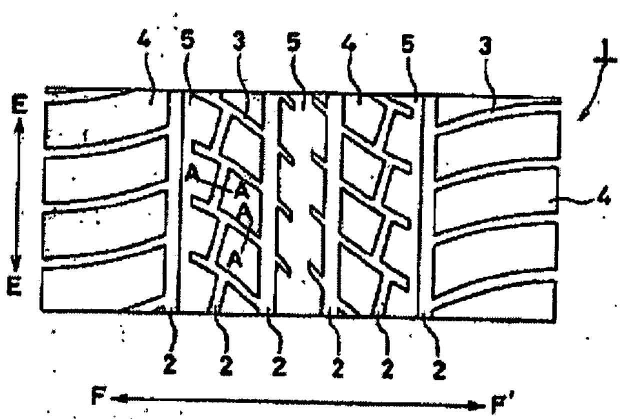

Figure 8

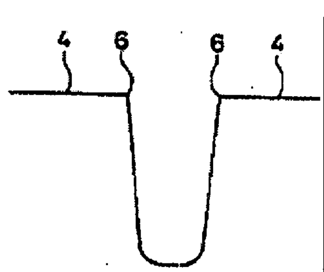

Figure 9